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The Physical Sciences: PROFESSOR W. L. BRAGG 237

The Supreme Intellectual Obligation: PROFESSOR JOHN DEWEY 240

Scientific Events:
Research in the British Post Office; The Leverhulme Research Fellowships in Great Britain; Hunan-Yale Public Health Project in Changsha Schools; Report on the Electrical Hazards of Aircraft; Stream Surveys in the National Parks by the U. S. Bureau of Fisheries; The New York State Planning Board 243

Scientific Notes and News 246

Discussion:
Movement of Pigment Granules in Chromatophores: PROFESSOR S. O. MAST. *Advancing Glaciers in Alaska:* H. B. WASHBURN, JR. *German Periodicals and American Libraries:* CHARLES H. BROWN. *The United States Botanic Garden:* W. J. YOUNG. *Decrease in Government Appropriations for Entomological Work:* PROFESSOR C. L. METCALF and PROFESSOR E. F. PHILLIPS 249

Scientific Apparatus and Laboratory Methods:
An Extractor for Fluid Systems: DR. WILLIAM F. BRUCE 253

Special Articles:
St. Louis Encephalitis: DR. LESLIE T. WEBSTER and DR. GEORGE L. FITE. *An Attempt to Isolate Vitamin A:* PROFESSOR HARRY N. HOLMES, HAROLD CASSIDY, EVA HARTZLER and RICHARD MANLY. *The Effect of X-Rays on Growth Substance and Plant Growth:* FOLKE SKOOG 254

Science News 8

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THE PHYSICAL SCIENCES[1]

By Professor W. L. BRAGG, F.R.S.

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MAY I first express my warm appreciation of the invitation you have extended to me to spend this semester at Cornell as your non-resident lecturer. It is an invitation of long standing, for on two occasions circumstances have made it necessary to postpone my visit, and I am warmly grateful to Professor Dennis and Professor Papish for their kindness in keeping the invitation open for so long. This is my third visit to your country, and my experience of your hospitality tells me what a very delightful stay this will be. I am glad of the occasion which this introductory lecture affords to express my gratitude.

When a scientist comes out into the open, away from the safe retreat of his own special line of work, he puts himself in a very dangerous position. In his own line he has some claim to expert knowledge. He can at all events save himself from falling into pitfalls of crudeness and naïveté, which will be ready for him if he wanders off the tract he knows. If I venture to talk about very general aspects of the physical sciences, I must try to disarm your criticism beforehand. I wish to show my appreciation of the invitation which you extend to your non-resident lecturers to talk to an audience with wide and varied interests. It would not be fair to ask you to take an interest in my own particular department of physics.

I want to talk about the development of the physical sciences, and review the general trend of the bewilderingly rapid advances of recent times. I must feel very diffident in proposing this as a subject, in view of the extent to which it has been treated by far more able exponents. On the other hand, it is of such interest and importance for us all that perhaps no ex-

[1] Introductory public lecture.

cuse is necessary for seizing an opportunity like this to discuss it.

I suppose it is a very common experience for those of us who study the physical sciences to be asked what "Physics" is. This not infrequently happens to me, for example, at dinner parties when the lady I sit next to, after angling a little to find out what sort of person I am, elicits the information that I am university professor of physics. My interlocutor generally has an idea that it is not something to do with medicine, though it sounds like it; I take refuge in murmuring something about "heat, light, sound, electricity and magnetism." It is an embarrassing, but very illuminating instance of the way in which one of the most significant factors for the future of our modern civilization, the increased power over nature due to the growth of the physical sciences, is quite incomprehensible to all but the few who make it their especial study.

I wish to class together all the physical sciences which seek to study nature as a mechanism, as distinct from pure mathematics and the biological sciences which deal with living matter. We seek to find out the way in which nature works as we may study the working of a machine. We try to do this as accurately as we can, to express everything as quantities; for this reason physical science is called the science of measurement.

There have been three well-marked stages in the attempt to explain nature in this way. In the first stage, some little bit of nature was selected, simplified, and isolated from the rest so that the sequence of cause and effect could be studied. We all start in this way when we learn physics at school. We work out the way in which a pendulum will swing, having been told its length and the pull of gravity, or the way in which a stone drops (the friction of the air being neglected). The interesting thing about physics of this kind is that we put ourselves in the glorious position of being (on paper) omniscient. We know all the facts to start with, and we can say exactly what is going to happen unless we make a howler in our calculations. The equally interesting consequence is that the events so described are eternal. As Eddington puts it, the arrow of time, distinguishing the future from the past, ceases to exist. The schoolboy, given the necessary data, could tell you what the pendulum was doing when William the Conqueror landed in 1066, and what it will be doing at any time in the future, for the definition of his problem includes no interference from outside. The ideal pendulum, or any other isolated natural phenomenon, has no history. It works equally well forwards or backwards. It can never surprise us by an unexpected turn; how can it when we are omniscient? Time has ceased to exist, except as a convenient label for the different parts of a completely known whole.

Nothing really happens in this way, though some bits of nature, like the rotation of the earth, approach very closely to it. We are almost omniscient as regards the rising of the sun to-morrow morning. The increasingly ambitious physicist tried to tackle problems where he could not say he knew all the initial conditions, and was able to do it with success. This success ought not to surprise us, for we can draw many parallels. A life assurance company does not know everything about the people on its books, yet it can calculate its premiums to a nicety and be confident of a profit on the year's working. It does not know when Smith or Robinson will die, but a study of vital statistics has led to a knowledge of what the average expectation of life of a large number of Smiths and Robinsons will be. We treat a body like a gas in the same way. It consists of vast numbers of molecules flying about in all directions. We do not know what they are all doing, yet we can discover laws which the gas as a whole will obey very accurately indeed. An engineer can calculate the power his steam engine will develop, although the individual molecules in the steam are pursuing their lively careers in a way of which he is completely ignorant.

Although we have ceased to be omniscient, we may still picture some one, more clever than ourselves, who is omniscient. An ideal physicist with all the possible resources of apparatus at his command and infinite patience might size up the flight of every molecule, and by using mechanical laws might predict what they were all going to do at any future time. The theoretically possible existence of such an ideal physicist would be sufficient to determine our attitude to this world around us. It implies that the gas, or the universe, is as timeless and as determined by physical law as the ideal pendulum; it is only more complicated. It has equally no history and no development; its whole past and future are sufficiently described by an accurate description of its present state. This is the logical reasoning which leads to a purely deterministic attitude. The events of to-morrow may surprise us because we are not clever enough to know all about the purely physical to-day; but if we knew all about to-day we would know the end of the story. We feel the difficulty of escape from this deterministic attitude, sensing that somehow it is wrong but unable to see how to avoid it.

There is an important qualitative difference between the simple pendulum and the complex world, however. In such complex events as the above, Eddington's arrow of time comes in. Things do not work as well backwards as forwards. A hot body is placed in contact with a cold one, and by the jostling

their atoms they take up the same temperature. We do not see the reverse process of two bodies initially at the same temperature growing hot and cold, respectively. Eddington cites the more complex case of a cup falling off the table and smashing to pieces. If at a given instant the velocities of every fragment were reversed, the pieces would fly together, form a whole cup and leap on to the table. This would surprise us, and we accept more readily the time sequence of a whole cup becoming fragments than the reverse sequence. It must be realized, however, that a time sequence only comes in here because we suppose an initial something which from the point of view of physics is miraculous. A whole cup is a miracle, not of course in the sense that it is against the laws of physics, but in the sense that no unaided physical causes will produce it. In a less obvious sense, we must start with some original miraculous state of affairs in order to have two bodies at different temperatures. Physical processes may destroy the miraculous but can not create it. We may say again that history (meaning by history a sequence of events for which only one time-order is natural) only exists as a record of miracles, or rather of the consequences of an initial miracle whose origin transcends the merely physical. Apart from the miraculous, history and time have no meaning except as a system of labels. The running down of the world, so often quoted as one of the results of physical laws, is evidence of something quite apart from physics. It is the changing aspect of an initial state whose creation is not contemplated by physical laws.

The last stage is more difficult to describe. It is more recent, and there has not been time to realize its implications fully. In picturing the ideal physicist examining every detail of the gas, we have tacitly assumed that his delicate apparatus feels all round every molecule with tentacles so sensitive that they do not disturb it in any way. This is not possible, however. Given the most delicate apparatus in the world, the collection of information about the gas in some headquarters means that each molecule has sent a message, necessarily an ether wave because that is the only way in which a message can travel from one point to another. Forcing it to send such a wave by throwing light on it is again of necessity a brutal cataclysmic process. The molecule has a nasty shock, and is not the molecule it was before. Further, we can not say exactly how the shock has affected it, except by making it send another message at a future time. This gives it another shock and though we have succeeded in discovering what it has been doing in the past we are as badly off as before as regards predicting its future. It is important to realize that the shock is received because the molecule, having had light directed upon it, sends a message betraying its whereabouts; the shock has nothing whatever to do with the apparatus receiving the message, which we may make as delicate as we like.

We may compare it, rather inaccurately, to a grown-up watching children at play. He wishes to remain unobserved himself; otherwise the little beings will become self-conscious and their antics will not be those they would have indulged in had they been left alone. It is impossible to remain unobserved, however, because he can only discover what they are doing by making them describe it to him. We can not as physicists be non-interfering observers of any object in front of us; we must interfere with it, and the consequences of the interference can not be exactly predicted. Or we may go back to our insurance company. If it wished to calculate its profits for the coming year to the last penny, it might send an army of doctors to visit all its policy holders, make a report on their state of health and home life, and predict precisely when the company would have to pay up for each of them. We must suppose, however, in comparing the company with the physicist examining matter, that the examination itself put the patient in such a nervous twitter as to make him an altered man. A subsequent examination would show how he had been altered by the last, but would again introduce a new incalculable element.

What inference is to be drawn from all this? The statement, "If I know the precise present physical state of an object in front of me, I can predict its future," is seen to be meaningless. The object can not reveal its present state without altering its future. Omniscience as an ideal and a precise connection between cause and effect are seen to be illusions as regards the physical world. This does not mean that the incalculable element which upsets our precise physical predictions is necessarily an element of blind chance. To think this is as revolting as is the previous deterministic attitude. A more attractive way of accepting the new view-point is to consider that those qualities of any object in front of us which can be measured by any purely physical means do not sum up the whole of the truth about it. The physical nature of a body is merely its projection upon one plane (like the plan of a building without the elevation). The body has an extension in other directions, other qualities which are not expressed in physical measurements. This does not imply that the laws of physics do not hold universally. The plan upon the physical plane is self-consistent and governed by universal law to which we find no irrational exceptions. It is nothing but the truth, but not the whole truth.

When a physicist talks like this, he is often told by friends with a philosophic turn of mind that physicists have found nothing new. I can not accept this. I am sure that when the first circumnavigators of the world returned from their voyage they were told by friends that some Greek philosopher, who lived in ? B. C. had held that the world was round and that they might have spared their trouble. The world is either round or flat, and endless discussion might have been carried on for ages between opposing schools who held the one view or the other. The real contribution to settling the problem was made by the circumnavigators. The achievement in physics which I have tried to outline is like a circumnavigation of the physical world. There will be no end to further exploration, but we realize for the first time certain bounds within which it must take place, just as we now know that geographical exploration must take place over the surface of a globe and not upon an infinite plane.

To summarize, let me try to explain by an analogy the position in which we find ourselves as students of the mechanism of nature. You know those large glass-paned floors which often form the pavement of an upper room or of the street, which are such that any one in a lower room can look upwards and see the footsteps of people passing above. Let us suppose a physicist placed in such a lower room, and that his sole means of observing what was going on above was by observation of the feet of the passers by, and of anything else in contact with this glass floor. He could learn a great deal and would be able to formulate laws. He would observe that footsteps did not suddenly disappear into space—the indestructibility of matter. He would observe that the footsteps always passed around objects and not through them—the impenetrability of matter. Starting in one direction they on the average pursue the same direction, though fluctuations from the average are evident. Sometimes a foot slips; such a phenomenon is generally followed by violent movements of the feet and their disappearance altogether, followed by the appearance in their place of an object of roundish outline—a kind of radio-active transformation. The laws governing a crowd of footsteps all moving in one direction would be more exact than those applying to a single individual. Yet he could never predict exactly what they would do.

We may make our analogy a closer one by supposing that we can only tell where the footsteps are, not by looking at them, but by reaching up and tweaking their toes. A light tweak has little effect on their movements, but leaves us uncertain of their exact position. A heavy pinch tells us exactly where they are, but causes them to swerve from their course in an erratic way which we can not predict. To see where they have got to, we must pinch again, and this introduces a new element of uncertainty into the future, though it tells us what has happened in the past. The physicist might be tempted to say that an element of blind chance enters into the behavior of all he observes, upsetting his precise calculations. We know that he would be wrong. The objects above exist in a third dimension of which he is unaware.

Is not this precisely our position as regards the physical world? The same element of uncertainty enters into all our physical calculations, and does so not because our instruments are imperfect, but because of the very nature of physical laws. We must think of the physical world around us as the footprints of something which exists in other dimensions as well, which has other qualities which are not physical and which no physical apparatus, however delicate, can measure.

It seems to me that this is the contribution which recent developments of the physical sciences makes to human knowledge. Nothing can exceed our instinctive horror of the finite, our revulsion at the idea of being entrapped in a mechanical web. Science now suggests the way of escape from a dilemma, for which its own logical pursuit has been largely responsible.

THE SUPREME INTELLECTUAL OBLIGATION[1]

By Professor JOHN DEWEY

THE scientific worker faces a dilemma. The nature of his calling necessitates a very considerable remoteness from immediate social activities and interests. His vocation is absorbing in its demands upon time, energy and thought. As men were told to enter their closets to pray, so the scientific man has to enter the seclusion of the laboratory, museum and study. He has, as it is, more than enough distractions to contend with, especially if, as so often happens, he is also a teacher and has administrative and committee duties. Moreover, the field of knowledge can not be attacked *en masse*. It must be broken up into problems, and, as a rule, detailed aspects and phases of these problems must be discriminated into still lesser elements. A certain degree of specialization is a necessity of

[1] The undersigned served as a committee to make the plans for a dinner held in the honor of Dr. J. McKeen Cattell, at the University Club, Boston, Wednesday evening, December 27, 1933. At that time an address was given by Dr. John Dewey. The committee has requested SCIENCE to publish Dr. Dewey's address.

OTIS W. CALDWELL
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HENRY B. WARD

scientific advance. With every increase of specialization, remoteness from common and public affairs also increases. Division of labor is as much a necessity of investigation into the secrets of nature and of man as it is of industry.

Nor does aloofness reach an end in this point. The language in use for common communication does not fit the needs of statement of scientific inquiries and results. It was developed for other purposes than that of accurate and precise exposition of science, and is totally unfitted to set forth comprehensive generalizations in exact form. The result is that the scientist speaks what for the mass of men is an unknown tongue, one that requires much more training to acquire than any living speech or than any dead language. He can speak directly about his own affairs and problems only to a comparatively small circle of the initiated.

These considerations define one horn of the dilemma. The other horn is constituted by the fact that the scientist lives in the same world with others, and a world that is being made over by the fruits of his labors. There is hardly a single detail of our common and collective life, whether in transportation of persons and goods, in modes of communication, in household appliances and conveniences, in medicine, in agriculture and all the varied forms of productive industry, that is not what it is to-day because of what science has discovered. The scientist may be aloof in his work and language, but the results of his work pervade and permeate, they determine, every aspect of social life. The inventor, the engineer and the business man are unremittingly occupied with translating what is discovered in the laboratory into applications of utensil, device, tool and machine, which have largely revolutionized the conduct of life in the home, the farm and amusement as well as industry. I could easily spend many times my allotted time in a partial cataloging of things unknown fifty years ago that are now everyday necessities.

These consequences of science extend their influence far beyond what anthropologists call material culture. They affect institutions and great modes of interest and activity. We have broken with the intellectual traditions of the past and the mass of men have not had the nature of the change interpreted to them, although science set the terms on which men associate together. They transform life in ways that have created social problems of such vastness and complexity that the human mind stands bewildered. The intellect is at present subdued by the results of its own intellectual victories. It has become a commonplace to refer to consequences of chemistry in its application to warfare. High explosives, with their allies of steel and airplane derived from physics, are capable of destroying every city on the face of the earth, and we are even threatened with bacterial warfare. If the problems of peace and war have assumed a new and unprecedented form—which, alas, the nations are meeting for the most part only by increased expenditures for armament—it is because of applications of scientific knowledge.

I have selected but one aspect of the question. The economic problem which weighs so heavily upon us to-day affords another illustration of the new social impact of science. Here too it is a commonplace that mankind in advanced industrial countries and especially in the United States confronts the paradox of want in the midst of plenty. It is science which, through technological applications, has produced the potentiality of plenty, of ease and security, for all, while lagging legal and political institutions, unaffected as yet by the advance of science into their domain, explain the want, insecurity and suffering that are the other term of the paradox.

My title is the supreme intellectual obligation. But every obligation is moral, and in its ultimate consequences social. The demands of the situation can not be met, as some reactionaries urge, by going backward in science, by putting restrictions upon its productive activities. They can not be met by putting a gloss of humanistic culture over the brute realities of the situation. They can be met only by human activity exercised in humane directions. The wounds made by applications of science can be healed only by a further extension of applications of knowledge and intelligence; like the purpose of all modern healing the application must be preventive as well as curative. This is the supreme obligation of intellectual activity at the present time. The moral consequences of science in life impose a corresponding responsibility.

As with almost everything in contemporary life, it is easier to diagnose the ill than to indicate the remedy. But there are some suggestions that occur to all who reflect upon the problem. The field of education is immense and it has hardly been touched by the application of science. There are, indeed, courses in science installed in high schools and colleges. That much of the educational battle has been won, and we owe a great debt to those who waged the battle against the obstacles of tradition and the inertia of institutional habit. But the scientific attitude, the will to use scientific method and the equipment necessary to put the will into effect, is still, speaking for the mass of people, inchoate and unformed. The obligations incumbent upon science can not be met until its representatives cease to be contented with having a multiplicity of courses in various sciences represented in the schools, and devote even

more energy than was spent in getting a place for science in the curriculum, to seeing to it that the sciences which are taught are themselves more concerned about creating a certain mental attitude than they are about purveying a fixed body of information or about preparing a small number of persons for the further specialized pursuit of some particular science.

I do not mean of course that every opportunity should not be afforded the comparatively small number of selected minds that have both taste and capacity for advanced work in a chosen field of science. But I do mean that the responsibility of science can not be fulfilled by educational methods that are chiefly concerned with the self-perpetuation of specialized science to the neglect of influencing the much larger number to adopt into the very make-up of their minds those attitudes of open-mindedness, intellectual integrity, observation and interest in testing their opinions and beliefs that are characteristic of the scientific attitude.

The problem is of course much broader than the remaking of courses in science, which is nevertheless requisite. Every course in every subject should have as its chief end the cultivation of these attitudes of mind. As long as acquisition of items of information, whether they be particular facts or broad generalizations, is the chief concern of instruction, the appropriation of method into the working constitution of personality will continue to come off a bad second. Information is necessary, yes, more than is now usually obtained. But it should not stand as an end in itself. It should be an integral part of the operations of learning that construct the scientific attitude; that are, indeed, a part of that attitude, since the scientific inquirer is above all a continuing and persistent learner. As long as intellectual docility is the chief aim, as long as it is esteemed more important for the young to acquire correct beliefs than to be alert about the methods by which beliefs are formed, the influence of science will be confined to those departments in which it has won its victories in the past. I can not refrain from saying that one great obstacle is that many scientific men still hold, implicitly if not expressly, that there is a region of beliefs, social, religious and political, which is reserved for sheer acceptance and where unbiased inquiry should not intrude.

There is, moreover, a virgin field practically untouched by the influence of science. Elementary education is still a place for acquiring skills and passively absorbing facts. It is generally now admitted that the most fundamental attitudes are formed in childhood, many of them in the early years. The greatest indictment that can be brought against present civilization, in its intellectual phase, is that so little attention is given to instilling, as a part of organic habit, trust in intelligence and eager interest in its active manifestation. I take little interest in demonstrations of the average low level of native intelligence as long as I am aware how little is done to secure full operation of what native intellectual capacity there is, however limited it may be. Speaking generally, it is now everywhere subordinated to acquisition of special skills and the retention of more or less irrelevant masses of facts and principles—irrelevant, that is, to the formation of the inquiring mind that explores and tests. Yet childhood is the time of the most active curiosity and highest interest in continual experimentation. The chief responsibility for the attainment of a system of education in which the groundwork of a habit and attitude inspired and directed by something akin to the method of science lies with those who already enjoy the benefits of special scientific training.

I have spoken chiefly with respect to the education of the schools. But the problem and the responsibility of education go deeper. There are some signs of a rebirth of the educational interest that marked the Greeks who thought of it, as far as we can gather from the records, chiefly in terms of adults. The theme of adult education is in the air. There was never a time in the history of the world in which power to think with respect to conduct of social life and the remaking of traditional institutions is as important as it is to-day in our own country. There is an immense amount of knowledge available, knowledge economic, historical, psychological, as well as physical. The chief obstacle lies not in lack of the information that might be brought to bear, experimentally, upon our problems. It lies on the one hand in the fact that this knowledge is laid away in cold storage for safe-keeping, and on the other hand in the fact that the public is not yet habituated to desire the knowledge nor even to belief in the necessity for it. Hunger is lacking, and the material with which to feed it is not accessible. Yet appetite grows with eating. The trouble with much of what is called popularization of knowledge is that it is content with diffusion of information, in diluted form, merely as information. It needs to be organized and presented in its bearing upon action. Here is a most significant phase of the obligation incumbent upon the scientifically trained men and women of our age. When there is the same energy displayed in applying knowledge to large human problems as there is to-day in applying it to physical inventions and to industry and commerce many of our present problems will be well on their way to solution.

I can not close without reference to the pertinence

of the theme discussed, however inadequate its mode of presentation, to the honored guest of the evening. James McKeen Cattell is himself an active scientific worker, one who has initiated in his own field of psychology many movements that have borne rich fruit. But he has found time, thought and energy to devote to the larger questions of the bearing of science upon life. He has given himself without stint to the better organization of scientific workers in all fields; he has striven valiantly for moral and financial improvement of the condition of academic workers; he has been the leader to the task of editing and diffusing the achievements of scientific inquiry. I do not need to press home the moral in connection with the intellectual obligation of which I have spoken. Laboring of the point is unnecessary as long as we have Cattell with us. He is a living example of the ways in which a scientific man can perform the supreme intellectual duty and as such we gladly greet and honor him this evening.

SCIENTIFIC EVENTS

RESEARCH IN THE BRITISH POST OFFICE[1]

WHEN the state purchased the telegraphs in Great Britain in 1869, the number of electrical workers in the whole country could almost be counted on the fingers. To-day the engineer-in-chief of the Post Office controls a staff of about 30,000 and maintains plant of a value of 130 million pounds. Starting from the needle instruments, skilled Post Office experimentalists developed the Wheatstone transmitter and receiver; instruments capable of operating up to 300 words per minute.

Captain B. S. Cohen, the engineer of the Post Office Research Station at Dollis Hill, in a paper read to the Institution of Electrical Engineers on February 1, said that these instruments still stand unsurpassed today in their design, workmanship and performance. It was not until 1912 that a research section was established. During the war period, the thermionic valve was perfected and at one stroke opened a boundless vista of possibilities in the way of universal telephone communication. The paramount necessity was to obtain the closest coordination between the research and the operating organizations. Without full access for research purposes to the working telegraph and telephone plant, the work of the research engineers would have been immensely increased. The Research Station at Dollis Hill was started in 1921 by using ex-army huts, and the permanent buildings were completed last year. Much excellent work has been done at this station which could not have been done elsewhere.

To the research workers at Dollis Hill the increase in the volume and weight of road traffic brought with it a new problem. There are apparently under the streets an ever-increasing number of cracked gas mains. Modern road surfaces make it difficult for this gas to escape into the open and so it sometimes accumulates in Post Office cable ducts and manholes, involving a serious hazard. The research engineers have developed a simple form of gas detector for general issue to Post Office workmen. The detector operates in a way somewhat similar to a photographic exposure meter. It utilizes a filter paper moistened with a few drops of palladium chloride solution and will indicate the presence of 0.05 per cent. of carbon monoxide, the dangerous constituent of coal gas.

The capital value of automatic switching apparatus installed in exchanges is now very large, and great precautions against corrosion have to be taken. Sir Robert Hadfield has said that the corrosion of iron and steel alone costs the world 700 million pounds per annum. Experiment shows that the life of galvanized iron stay wire is proportional to the thickness of the galvanizing. In some parts of south Lancashire, the normal life of a stay wire is little more than two years. It is now possible to estimate the life of any particular grade of wire in a given area.

In long telephone lines the "echo" used to be very troublesome but the engineers have invented, using valves only, a very efficient echo-suppressor. A non-reflecting room at the station has linings of cotton-wool one foot thick. This room has a totally silent background of noise. It is especially useful for listening tests where the threshold of hearing has to be found.

[1] *Nature.*

THE LEVERHULME RESEARCH FELLOWSHIPS IN GREAT BRITAIN

THE Advisory Committee of the Leverhulme Research Fellowships invite applications for 1934. These fellowships will be awarded to citizens resident in the United Kingdom for the assistance of experienced workers rather than to add to the provision already existing for workers in the early stages of their careers. The trustees have in mind particularly men and women who are prevented either by pressure of routine duties or by any other cause from undertaking or completing an investigation of value. No definite limit will be placed on the amount of individual grants, but they will be adjusted according to the circumstances of each particular case. Fellows will usually be required to work at or in connection with a recognized

center of research, either at home or abroad. Under present conditions preferential consideration will be given to subjects for which existing provision is inadequate.

From the large number of applications received last year, 17 selections have been made by the Advisory Committee and approved by the trustees of the will of the late Lord Leverhulme. These are for varying periods up to two years. The names of the fellows in the sciences and the subjects of the researches are as follows:

E. C. BULLARD, demonstrator in geodesy, University of Cambridge, "Gravity and Magnetic Measurements." Research to be carried out in Great Rift Valley, East Africa.

C. R. BURCH, physicist, Metropolitan-Vickers Electrical Company, Ltd., "On the Production of Aspherical Optical Surfaces and on Their Imaging Properties in Combination."

F. FRASER-DARLING, chief officer, Imperial Bureau Animal Genetics, Edinburgh, "An Ecological Study of a Herd of Scottish Red Deer, with Special Reference to Behavior."

C. S. ELTON, director of the Bureau of Animal Population in University of Oxford and university demonstrator in zoology, "Fluctuations in Numbers of Wild Mammal Populations."

D. H. HAMMICK, fellow and tutor, Oriel College, Oxford, "Investigations on the Interaction of Nitro-compounds with Aromatic Bases and Hydrocarbons."

H. S. HATFIELD, London, "The Behavior of Crystalline Substances in Electric and Magnetic Fields."

L. S. B. LEAKEY, fellow of St. John's College, Cambridge, "The Prehistory of East Africa."

D. L. R. LORIMER, lieutenant-colonel, Indian Army (retired), late of Foreign and Political Department, "Anthropological and Linguistic Research in the Gilgit Region of the Karakorum and Hindukush."

A. G. LOWNDES, Marlborough College, Wilts, "The Polygraphic Process." Ultrarapid cinema-photo-micrography.

HUNAN-YALE PUBLIC HEALTH PROJECT IN CHANGSHA SCHOOLS

A SPECIAL government grant of $12,000 Chinese currency has been made to the Hunan-Yale Medical School by the Hunan Provincial Government to carry on a public health program in the schools of Changsha. Sixteen schools in the north of Changsha have been chosen as a starting point for the new project, and it is estimated that 6,000 students, most of them of primary grade, will be reached. Chu King-lung, Commissioner of Education, has been appointed chairman of the committee, while Dr. K. Y. Wang, president of the Hunan-Yale Medical School, is to be vice-chairman, and Dr. L. S. Liu, of the department of preventive medicine at Hunan-Yale, will act as general secretary.

The project as outlined by the committee includes health education in the schools through lectures, lantern slides, exhibits, habit training classes, etc. This branch will be chiefly for the students themselves, but additional material will be presented to cooperating parents. There will be an annual physical examination of all students in these schools, with careful records and a monthly check-up in weight and height. The program also includes a weekly clinic for correction of defects as far as possible; inspection for infectious diseases, preventive inoculation, isolation and sanitary inspection of school and grounds.

Two doctors and four trained public health nurses will be assigned to this work. The additional grant for this purpose is a significant indication of the interest of the government, coming as it does at a time of financial stringency. The principals of the sixteen schools affected have expressed their hearty endorsement of the project.

The Hunan-Yale Medical School was started in 1914 as a joint enterprise between the Hunan Provincial Government and Yale-in-China, and it is believed that this new plan will give a great opportunity to aid in health education. It is said that many fields of preventive medicine require more in the way of finance and government organization that can be afforded, but that this development is within present facilities, especially as there is a growing interest in public health measures. The Hunan-Yale Hospital now has 180 beds, with a special children's ward, and is equipped to carry on the treatments that may be needed for conditions found in the health examinations.

REPORT ON THE ELECTRICAL HAZARDS OF AIRCRAFT

A SUB-COMMITTEE of the National Advisory Committee for Aeronautics has issued a report on the results of an investigation made at the request of the Navy Department on "Hazards Due to Electrical Phenomena."

Members of the committee appointed by Dr. Joseph S. Ames, president of the Johns Hopkins University and chairman of the National Advisory Committee were: Dr. Charles F. Marvin, Weather Bureau, *chairman;* Dr. L. J. Briggs, Bureau of Standards; Commander Garland Fulton (C. C.), U. S. N.; Dr. W. J. Humphreys, U. S. Weather Bureau; Dr. J. C. Hunsaker, Massachusetts Institute of Technology; Dr. F. B. Silsbee, Bureau of Standards; Professor John B. Whitehead, the Johns Hopkins University; Dr. G. W. Lewis, National Advisory Committee for Aeronautics (*ex officio*). They were assisted by Dr. M. F. Peters, of the Bureau of Standards.

The findings of the committee as summarized by Science Service are as follows: An airship inflated with inflammable hydrogen is no more liable to dam-

age from lightning than one inflated with non-inflammable helium, provided it is properly "caged" with electrically conducting metal framework. In the airship the protection is greater the closer the meshes of the metallic framework, the wire bracing and the wire netting enclosing the gas bags, and particularly the more highly electrically conducting the surface of the outer envelope.

A number of reports of damage by lightning to airplanes are reviewed. It was generally agreed that "It is possible, without serious complication, to render an airplane practically immune to serious danger either to the airplane or to the occupants."

Though neither airplanes nor airships are in serious danger from lightning, it is important that every effort be made to avoid thunderstorms. The violent winds during thunderstorms, rather than the lightning, are the cause of destruction.

STREAM SURVEYS IN THE NATIONAL PARKS BY THE U. S. BUREAU OF FISHERIES

THE program of stream surveys in the national parks and forests to be conducted by the Bureau of Fisheries on funds allotted by the Public Works Administration is rapidly nearing completion. On January 8 and 9 a conference of the administrative and supervisory personnel was held in Washington, D. C., for the consideration of details of this organization. Besides the administrative officers of the bureau, the conference was attended by Dr. H. S. Davis, who will have general technical supervision of the investigations, and by Dr. A. S. Hazzard, Dr. P. R. Needham and Dr. Eugene Surber, all of the regular scientific staff.

The purpose of this survey is to formulate a sound scientific stocking and improvement program for the most heavily fished waters of the national forests, based on an actual assessment of the physical and biological characters of the streams and lakes within the areas studied. The improved program of planting resulting from such a survey will effect material economies by coordinating the activities of the Federal and State Governments engaged in stocking public waters, and in addition recommendations will be offered to the Forest Service for the more effective improvement of stream conditions, utilizing the services of the emergency conservation workers. Owing to the limitation of trained personnel, however, recommendations for stream improvement will be offered only in the particular forest areas that can be surveyed by the various bureau parties in the field. Since there are upward of 120 national forests, these recommendations for improvement will cover but a very small portion of the national forest areas.

The survey program will be organized in three major sections: The eastern section, including a part of forest area 7; the intermountain section, including parts of forest areas 1, 2, 3 and 4; and the western section, including selected forests in area 5.

Four survey parties will be placed in the field in the eastern section. One will operate in the Pisgah National Forest, parts of the Great Smoky National Park, and a portion of the Nantahala National Forest, where work will be undertaken about March 15; one in the George Washington and Monongahela National Forests and a portion of the Shenandoah National Park; one in the White Mountain National Forest and adjacent regions in New Hampshire, and one in the Green Mountain National Forest and the Battell Forest and adjacent regions in Vermont. Work in the latter areas can not begin before April or May owing to climatic conditions.

In the intermountain region one party will work in Glacier National Park, completing the surveys that have already been undertaken in the past. One will be assigned to each of the seven Intermountain States, including Idaho, Wyoming, Nevada, Utah, Colorado, Arizona and New Mexico. In each case one or more national forests will be surveyed as fully as possible during the limited working season of midsummer.

In the western section three survey parties will be engaged in studying the waters of the Yosemite National Park and the Stanislaus, Tahoe, Klamath and Trinity National Forests in California. Weather conditions will not permit effective work in these high mountain areas until late in the spring.

In all, 15 parties will be placed in the field varying from 4 to 7 in number, including a skilled biologist in charge of the party; 2 to 4 assistant biologists and 1 or 2 unskilled assistants to assist in maintaining and moving the camps, caring for pack horses, trucks and equipment. In all approximately 85 persons will be employed for periods varying from 3 to 8 months.

THE NEW YORK STATE PLANNING BOARD

FUNDS have been placed at the disposal of the National Planning Board by the Federal Emergency Administration for Public Works for the employment of qualified experts to further the development of planning on a state-wide basis. As a condition of providing a technical adviser without expense, it is stipulated that state planning boards shall be appointed. The boards will work in cooperation with the National Planning Board as part of the Federal Recovery program. The Public Works Administration will defray expenses for salaries and for administrative work for six months.

Robert Whitten has been appointed expert director of the New York State Board, and Dr. A. R. Mann, provost of Cornell University, has been named chair-

man of the board. Other members are Colonel Frederick Stuart Greene, state superintendent of public works; Lithgow Osborne, state conservation commissioner; Henry F. Lutz, director of state parks and secretary of the State Council of Parks; Mrs. George M. Tyler, president of the State Federation of Home Bureaus; George McAneny, president of the New York City Regional Planning Association, and Miss Theodosia Burr, a member of the Dutchess County Planning Commission.

In a statement made public by Governor Lehman he says that it will be the function of the State Planning Boards to correlate the findings of the several departments, to gather such supplementary information as may prove useful and from the whole to formulate a broad plan of development for each state. This will include a determination of the usefulness of the principal regions within a state for agricultural, recreational, forest, watersheds, industrial, urban or other purposes and a study of the transportation facilities existing or required to survey these areas. It is planned that in New York State a preliminary survey and study include the various proposed public works projects and other related projects, both public and private, with a view to the possible development of a long-range program of public works.

SCIENTIFIC NOTES AND NEWS

THE formal presentation of the William H. Nichols Medal of the New York Section of the American Chemical Society was made to Dr. Henry C. Sherman, Mitchill professor of chemistry at Columbia University, on March 9 at the Chemists' Club, New York City, by Professor Victor K. LaMer, of Columbia University, chairman of the jury of award. The award was made to Dr. Sherman in recognition of his work on vitamins. Dr. John M. Weiss, chairman of the section, presided. The speakers were Dr. Lafayette B. Mendel, Sterling professor of physiological chemistry at Yale University, and Dr. C. A. Browne, of the Bureau of Chemistry and Soils, U. S. Department of Agriculture. Dr. Sherman spoke on the benefits of concentrating vitamins in foods.

A DINNER in honor of the seventy-fifth birthday of Dr. F. H. Herrick, professor emeritus of biology, was held recently at the Cleveland Club by the department of biology of Western Reserve University, of which Dr. Herrick was a member for forty-five years.

DR. IRVING LANGMUIR, associate director of the Research Laboratory of the General Electric Company, has been appointed for the academic year honorary chancellor of Union College, Schenectady, New York. Dr. Langmuir will deliver the principal address at the one hundred and thirty-eighth annual commencement exercises of the college on June 11.

DR. FRANK B. JEWETT, vice-president of the American Telephone and Telegraph Company and president of the Bell Telephone Laboratories, has been elected to life membership on the corporation of the Massachusetts Institute of Technology. Dr. Jewett had previously served a term as member of the corporation.

AT the recent annual meeting of the National Institute of Social Sciences, Dr. C. Stuart Gager was re-elected president for the third year. Dr. Gager has also been elected an honorary life member of the Pennsylvania Horticultural Society.

DR. THOMAS T. READ, Vinton professor of mining engineering at Columbia University, has been elected chairman of the Mineral Industry Education Division of the American Institute of Mining and Metallurgical Engineers.

THE title of "Honorary Fellow of University College, London" has been conferred on Dr. Karl Pearson, emeritus professor of applied mathematics and mechanics from 1884 to 1911 and Galton professor of eugenics from 1911 to 1913, and on Emeritus Professor Sir William Matthew Flinders Petrie, Edwards professor of Egyptology from 1893 to 1933.

THE Gold Medal of the Institute of Engineers of South Wales has been awarded to Professor A. E. Trueman, of the department of geology, University of Bristol, for his paper, "A Suggested Correlation of the Coal Measures of England and Wales," for being the most valuable paper received and published during 1933.

DR. ALLEN WEIR FREEMAN, professor of public health administration at the Johns Hopkins School of Hygiene and Public Health since 1923, will succeed Dr. Wade Hampton Frost as dean when Dr. Frost's term expires next July. Dr. Frost will continue his work as professor of epidemiology.

DR. FREDERICK CARPENTER IRVING was recently appointed William Lambert Richardson professor of obstetrics at Harvard University. Dr. Irving is the first incumbent of this chair, which was created last autumn under the will of the late William Lambert Richardson, formerly professor of obstetrics and dean of the Harvard Medical School.

JAMES ROBERT MATHEWS, professor of botany in the University of Reading, has been appointed Regius professor of botany at the University of Aberdeen, in place of the late Professor W. G. Craib.

DANIEL KASHKAROV, professor of vertebrate zoology at the Middle Asiatic State University, has joined

the staff of the University at Leningrad as head of the department of the ecology and biology of vertebrates.

JAY N. DARLING, of Des Moines, Iowa, has been appointed chief of the U. S. Bureau of Biological Survey to succeed Paul G. Redington, who has joined the Forest Service. Since January 6 Mr. Darling has served as a member of the President's committee on wild-life restoration. He is a member of the Migratory Bird Conservation Commission of the U. S. Department of Agriculture, of the Iowa Fish and Game Commission, of the Iowa Planning Commission and of the Des Moines Park Board. Mr. Darling is cartoonist for the *New York Herald-Tribune*.

THE Board of Trustees of the Tennessee Academy of Science has elected Dr. A. Richard Bliss, Jr., director of The Reelfoot Lake Biological Station.

DR. EDGAR ALLEN, professor of anatomy at the School of Medicine of Yale University, will be in charge of the course in surgical methods in experimental biology at the Biological Laboratory at Cold Spring Harbor this summer. It had been previously announced that Professor W. W. Swingle, of Princeton University, would give this course.

THE Council of the American Psychological Association has confirmed the election by the Board of Editors of the *Psychological Review* Publications of Professor Herbert S. Langfeld, Princeton University, as editor of *The Psychological Review* to succeed the late Professor Howard C. Warren, and the election of Professor Joseph Peterson, George Peabody College for Teachers, as editor of the *Psychological Monographs* to succeed Professor Langfeld.

MRS. LEE P. CUMMINS has been made director of the Museum of Natural History and Industrial Arts at Memphis, Tenn.

DEAN HARRY E. CLIFFORD, of the Engineering School of Harvard University, has been appointed by President Roosevelt a member of the Board of Visitors of the United States Naval Academy at Annapolis.

DR. WILLIAM LOUIS POTEAT, president emeritus of Wake Forest College, North Carolina, formerly professor of biology, has been appointed associate utility commissioner on the State Utility Commission.

OFFICIAL delegates of the United States to the ninth International Congress of Pure and Applied Chemistry, which meets at Madrid on April 5 are John Van Nostrand Dorr, president of the Dorr Company, Incorporated, and Burrows Morey, both of New York, and Dr. Lauder W. Jones, professor of chemistry at Princeton University and associate director in Europe of the division of natural sciences of the Rockefeller Foundation.

DR. HENRY C. TAYLOR, American member of the permanent committee of the International Institute of Agriculture, Rome, and Dr. Lore A. Rogers, chief of the division of research laboratories, Bureau of Dairy Industry, Department of Agriculture, have been appointed to represent the United States at the tenth International Dairy Congress to be held in Rome from April 30 to May 6.

DR. JAMES W. MCBAIN, professor of chemistry at Stanford University, has been invited to go to Soviet Russia to attend the Mendelejeff Centenary in September. He will leave in June. He expects also to attend the meeting of the British Association for the Advancement of Science, which will be held at Aberdeen from September 5 to 12.

DR. WILLIAM W. CORT, professor of helminthology at the Johns Hopkins University, will sail for Egypt on March 20, where he will carry on investigations on schistosomiasis and hookworm disease under the auspices of the International Health Division of the Rockefeller Foundation. While in Egypt he will be associated with Dr. C. H. Barlow, who is in charge of a special project which the foundation has been carrying on in Egypt for the study of these diseases during the last four years. Dr. Cort will return to the United States early in July.

A GRANT to enable Dr. William Beebe, director of the department of tropical research at the New York Zoological Park, to resume his work in Bermuda next summer has been announced by Dr. Gilbert Grosvenor, president of the National Geographic Society. The project to be carried on off the coast will be known as the National Geographic Society-William Beebe Expedition. Dr. Beebe will be accompanied by an assistant, and plans to descend nearly half a mile inside the bathysphere in which he previously made a record descent of 2,200 feet. The expedition will make its headquarters near Nonsuch Island, at Dr. Beebe's new laboratory near the Bermuda Biological Station. The work will start in June.

A GRANT of $300 was made recently to Dr. M. H. Frohberg, assistant in the department of geology at the University of Minnesota, by the Geological Society of America, to finance an investigation of the genetic relations of certain gold-bearing ores in Ontario. He plans to begin his investigation in July.

CHARLES CARPENTER, who for two years has been carrying on research on cellulose in Germany, will continue his work at the Carnegie Institute of Technology, Pittsburgh, under a du Pont industrial grant.

DR. CHARLES EDWARD SKINNER, of the Westinghouse Electric and Manufacturing Company, will sail from San Francisco on March 20 for Japan, where he will deliver the Iwadare lectures in a number of

the larger cities, at the invitation of the Iwadare Foundation through the Japanese Institute of Electrical Engineers. The institute sends each year a certain number of graduates to America and invites in return American lecturers to Japan. The Iwadare lectures were given last year by Dr. A. E. Kennelly, professor emeritus of electrical engineering at Harvard University.

THE Cutter Lecture on Preventive Medicine at the Harvard Medical School, Boston, was given by Dr. Karl Landsteiner, member of the Rockefeller Institute for Medical Research, New York City, on March 16. He spoke on "Immunochemical Specificity."

DR. FRANZ BOAS, professor of anthropology, Columbia University, spoke on "Race and Civilization" in the series of lectures being given on "Focal Problems in Modern Society" arranged by the New York University Extension Division.

PROFESSOR EDWARD KASNER, of Columbia University, is giving a series of four lectures during March before the People's Institute of Cooper Union, on "Number, Space, Astronomy, Physics."

DR. WILLIAM BRAID WHITE, director of acoustic research of the American Steel and Wire Company, Chicago, and chairman of the Committee on Acoustics of the American Society of Mechanical Engineers, gave a lecture demonstration on "Music for Eye and Ear" on March 9 before the Master Institute and the Educational Committee of the Roerich Museum, New York City. All proceeds from this lecture have been given by Dr. White to the educational fund of the museum.

SIR WILLIAM BRAGG lectured before the Royal Institution on March 1 on the "Elements of Crystal Analysis."

THE Romanes Lecture at the University of Oxford this year will be delivered by Sir William Rothenstein, principal of the Royal College of Art.

THE fifteenth annual meeting of the American Geophysical Union will be held on April 26 and 27 at the building of the National Academy of Sciences, Washington, D. C. The preliminary program is as follows: Thursday morning, April 26, the sections of geodesy, volcanology and terrestrial magnetism and electricity; Thursday afternoon, the sections of meteorology, seismology and hydrology; Friday morning, the sections of oceanography and hydrology; Friday afternoon, general assembly of the union.

THE fifth Scientific Congress of the Pan American Medical Association is being held on a sixteen-day cruise lasting from March 14 to March 30, which has left New York for La Guaria, Venezuela. The program consists of twenty-four papers which will be read during the voyage from Havana to Caracas.

THE twelfth International Veterinary Congress will be held at the Waldorf-Astoria Hotel, New York, from August 13 to 18. This is the first time the organization has met in the United States, previous meetings having been held in Europe. The congress will discuss advances in the science and practise of veterinary medicine and surgery and will consider practical veterinary questions of world scope. President Roosevelt is patron of the congress and Secretary of Agriculture Wallace is vice-patron. Professor Dr. E. Leclainche, director of the Bureau of Epizootics, Paris, France, is president of the permanent committee in charge of arrangements, and Dr. John R. Mohler, chief of the Bureau of Animal Industry, U. S. Department of Agriculture, is a vice-president and will present one of the principal papers. Others on the program connected with the Bureau of Animal Industry are Dr. W. E. Cotton, superintendent of the Experiment Station, Bethesda, Md.; Dr. A. E. Wight, chief of the Tuberculosis Eradication Division; Dr. M. Dorset, chief of the Biochemic Division; Dr. M. C. Hall, chief of the Zoological Division, and Dr. E. C. Joss, assistant chief of the Meat Inspection Division.

THE New York Hospital and Cornell Medical College Association has received $100,000 through a bequest of the late Edward Wright Sheldon, chairman of the Board of Trustees. Princeton University received 100 shares having a par value of $100 in the Princeton Inn.

THE department of botany of the University of Nebraska has recently secured the herbarium of the late Rev. John M. Bates. The collection includes about ten thousand specimens of flowering plants and fungi, among which are numerous valuable additions to the flora of the state. The fungus collection includes a number of specimens that represent new species. The Bates collection will be added to the herbarium of the Botanical Survey of Nebraska, which now numbers approximately forty thousand specimens. The general herbarium, which is also the property of the department of botany, now numbers four hundred thousand specimens, including many of the important American and foreign exsiccatae. The collections are housed in fire-proof quarters in Bessey Hall.

THE London correspondent of the *Journal* of the American Medical Association reports that an airplane is to be used in Rhodesia to put up poison barrages against locusts as they pass across the country. An apparatus for spraying powder into the air has been sent from England and will be attached to the wings of the airplane. When locusts are reported, the machine will go up in search of them and will attempt to fly along the front of the swarm, spraying poison into the air so that they will fly into it. This is said to be a new experiment in the use of air-

craft against destructive insects. An airplane has been used to dust such crops as cotton with insecticides and has helped to rid forests of pests, particularly in Canada. But not before has it been used against migrating insects. It will carry 300 pounds of sodium arsenite. The method will probably be to overtake a swarm at a high altitude, descend to its level and spread a curtain of fine powder before it. The powder is expected to remain suspended for some time and to cause heavy casualties in a long column.

DISCUSSION

MOVEMENT OF PIGMENT GRANULES IN CHROMATOPHORES

SUMNER[1] proposed to designate the pigment granules in a chromatophore a "chromatosome," and movement of the granules out into the branches of the chromatophore "expansion of the chromatosome" and movement in the opposite direction "contraction of the chromatosome." I presented evidence in opposition to this terminology.[2] Sumner[3] does not agree with me in the conclusion reached on the basis of this evidence. He appears to agree with me, however, in the contention that a chromatophore is somewhat like a branched, heavy-walled rubber tube closed at the distal ends of the branches and at the other end joined to a heavy-walled rubber bulb filled with pigment granules suspended in a fluid, and that movement of the granules in the chromatophore is due to action in the heavy walls which surround the cavity containing the granules. But he maintains, nevertheless, that "the chromatosome, *i.e.*, the aggregate assemblage of pigment granules does *expand* and *contract* in the same sense that a volume of gas expands and contracts," and he concludes: "If the words, as I have used them, are misapplied, it is likewise incorrect to speak of the expansion and contraction of the mercury in a thermometer or of the air in a tire-pump."

It does not seem to me that this contention is sound, for expansion in a gas is the result of the action of the molecules of which the gas is composed and it involves increase in volume, whereas the distribution of the granules in a chromatophore is due to action in the wall which surrounds the cavity containing the granules, not to action of the granules or the fluid in which they are suspended, and there is no increase in the volume of the granules or the fluid in which they are suspended.

If (in a system consisting of a rubber tube connected with a rubber bulb filled with granules suspended in a fluid) pressure were brought to bear on the bulb so as to force the granules out into the tube, I do not believe it would generally be said that the mass of fluid and granules in that system has expanded. Nor do I believe that if mercury were forced out of the bulb of a thermometer into the capillary, owing to contraction of the glass wall of the bulb, it would generally be said the mercury has expanded. I consequently see no reason why one should say the mass of granules in a chromatophore expands if some of the granules are forced out into the branches, owing to contraction in the heavy wall which surrounds the cavity in which they are found.

I therefore answer in the negative Sumner's question, "Is it not just as accurate to say that urethane, for example, causes the chromatosomes [in the chromatophores] to expand as to say that this drug causes the pigment particles in the chromatophores to spread out?" And if the two clauses in this question are made equally explicit (by adding the content of the brackets) the second clause is practically as simple as the first; and it has moreover the advantage of avoiding the addition of a new term to scientific literature, which is already overburdened with terms. This clause is however not ideal as it stands, for it may imply action on the part of the granules. It would be more explicit, I think, to say the drug causes spreading or better distribution of the granules. The language used should describe the changes in the position of the pigment granules in the chromatophores without implying changes in the volume of the granules, either individually or as a mass, and without implying action on the part of the granules.

S. O. MAST

THE JOHNS HOPKINS UNIVERSITY

[1] SCIENCE, September 29, 1933.
[2] SCIENCE, November 10, 1933.
[3] SCIENCE, January 5, 1934.

ADVANCING GLACIERS IN ALASKA

I AM interested to read in your "Items" column in the *Science Supplement* of January 26 that the only advancing glacier in Alaska to-day is the Taku.

I have led three expeditions into Alaska in 1930, 1932 and 1933 and devoted much of my time personally to the study of the existing glaciers in the Lituya Bay and Yakutat districts. Of the five glaciers which we have measured over this period of time at Lituya Bay and Crillon Lake, *all but one* are advancing at a rate of two feet per week or higher. This advance is so rapid in one case that the glacier has over-ridden its older lateral moraines and is at present plowing its way into a forest outside of its former limits, indicating that to-day this glacier (the South Crillon Glacier) is at its greatest extent, both lateral and longitudinal, in fifty years or more.

The earthquake advance theory formulated by Tarr and Martin in their "Alaskan Glacier Studies," pub-

lished by the National Geographic Society, may well be the cause of these advances, but the glaciers of this part of Alaska have not been studied in sufficient detail since the Tarr-Martin expedition for any definite conclusions to be drawn at the present time. It may be of interest to note that the Nunatak Glacier whose ice-front was surveyed by Tarr and Martin in 1909 has receded nearly *five miles* since that time, as shown by our aerial photographs of 1933. I hope that during the next two years we shall be able to execute a more accurate aerial survey of the glaciers at Yakutat to determine their relative motion to the old figures of 1909. The Hidden Glacier has receded at least two miles since that time, while the Turner, Haenke and Hubbard glaciers seem to show little change. Perhaps the most curious discovery of our 1933 expedition was one which we made at Crillon Lake in the Fairweather Range, where two glaciers terminate only a mile or so from each other. The first I have mentioned above as advancing rapidly into the forest outside of its old channel. The second has *retreated* at least one hundred yards in the last three years.

Alaska is a marvelous field for the study of glacial ice in motion, and it is surprising that so few parties have been able to make computations there in recent years.

H. B. WASHBURN, JR.

CAMBRIDGE, MASS.

GERMAN PERIODICALS AND AMERICAN LIBRARIES

SCIENTISTS and librarians have been disturbed for the last several years by the steadily increasing prices charged for scientific books and periodicals, particularly German publications in the biological and medical fields. The production costs and the prices of scientific periodicals have been increasing; library budgets as well as the income of professional classes who are subscribers to scientific periodicals have been decreasing. The attempt of German publishers to compensate for a decrease in the list of subscribers by an increase in subscription prices showed signs of failure even before the present depression started. The difficulties confronting both publishers and librarians were disclosed at various conferences of German publishers in Europe and at a joint conference held in Chicago in October between representatives of the German Börsenverein der Deutschen Buchhändler and librarians of many countries. A summary of the events leading to the present tentative understanding between librarians and German publishers may interest all who are concerned with the availability of reports of scientific research.

Complaints of the increasingly high prices charged for German scientific periodicals were published as early as 1928 in *Svenska Dagbladet* and the English periodical, *Nature*, later during 1931–1933 in SCIENCE, the *Journal of Higher Education* and other scientific periodicals of various countries, as well as in nearly all library journals. Protests were also made by scientific and medical associations both in this country and abroad. The basic complaint was the high price, which in the case of some periodicals was in excess of $200 a year. A further difficulty was due to the fact that many German publishers issued their periodicals irregularly (Zwanglose Hefte), charging for each number separately. Libraries found it impossible to ascertain the annual subscription price of any given periodical and to prepare a library budget at all accurate. The Börsenverein recognized the justice of these complaints as far back as 1931. Dr. Friedrich Oldenbourg,[1] the president of the Börsenverein, showed that the foreign market for German scientific publications, which was lost during the war, had been won back rapidly, but might be lost again. Dr. Oldenbourg was in almost exact agreement with the foreign critics. He earnestly advised a restriction in the extent of German scientific articles. However, the high prices showed no decrease and the complaints of scientific and library organizations continued with even greater vigor until by the summer of 1933 it became apparent that the American market for German scientific periodicals was in immediate danger of being almost completely lost.[2]

A meeting of representatives of German authors, publishers and librarians was held at Münster, on August 3, 1933. At the conclusion of the conference announcement was made that all members of the Börsenverein would be expected in the future to state subscription prices in advance; that a reduction of at least 20 per cent. in the content and price of the inflated (aufgeblähte) periodicals would be expected. This agreement met warm appreciation. However, some of the German publishers apparently believed that their high-priced periodicals were not inflated. A list of periodical prices issued in September indicated that the expectation of a 20 per cent. reduction would not be realized.

Immediate protests were made to the Börsenverein. Possibly as a result the Börsenverein decided to send two representatives to the international conference of the American Library Association in Chicago. The

[1] *Börsenblatt*, 98: 325–31, April 9, 1931.

[2] It should be noted that German authors, scientists and librarians almost universally recognized the justice of the complaints. *Cp.* article by Professor Dr. Hubert Naendrup, Rektor der Westf. Wilhelms-Universität, in *Mitteilungen des Verbandes der Deutschen Hochschulen*, 13: 114–35, October, 1933, and articles by Dr. Georg Leyh, of the University of Tübingen, in *Zentralblatt für Bibliothekswesen*, 50: 377–88, May, 1933, and 51: 81–97, January, 1934.

representatives selected were Dr. H. Degener, founder and director of the Verlag Chemie, and Dr. Ferdinand Springer, head of the firm of Julius Springer. An agreement was reached by which the house of Springer, which publishes the majority of the expensive German scientific periodicals, announced an average reduction of not less than 30 per cent. in the prices of periodicals costing over $40 per year. The German representatives stated that these reductions should be considered as only a beginning and that attempts would be made to restrict further the extent and price of German periodicals. The Münster agreement was considered "a point of departure and not the final stage in the deflation of German periodicals. An attempt will be made to encourage as far as is still necessary careful editorial selection of papers and illustrations. All Festschriften and Ergänzungsbände will be eliminated."

On the other hand, librarians present tacitly agreed that the German publishers should be given an opportunity to reorganize their editorial policies by eliminating the less valuable articles, condensing the length, omitting long historical introductions and especially avoiding duplication of material. Through these means it is hoped that the quality of German scientific publications, already highly esteemed, will be greatly improved.

Upon the return to Germany of the representatives of the Börsenverein a second conference of publishers and scientists was held at Frankfurt am Main on November 11. The principles of the Springer agreement were extended to other German scientific publishers. The following is a translation in part of the Frankfurt agreement.

The directors of the Gesellschaft Deutscher Naturforscher und Aerzte and the representatives of the scientific publishers agreed that the concessions desired and granted at the proceedings in Chicago are actually practicable and will contribute to bring real abuses to an end; they are calculated to prevent further harm to the dissemination of German scientific literature.

The Münster agreement on the 3rd of August, 1933, can serve as a foundation, but a further decrease of annual extent and price must follow. It is expected that the German scientific publishers will reduce all periodicals which cost annually more than 40 gold dollars at least 30 per cent. on the average in size and price. The greatest possible reduction is to be carried out for all periodicals which cost more than RM 60 annually. . . .

Those who participated in the Frankfurt conference were agreed that the obligations assumed must be and could be fulfilled if editors and publishers hand in hand would provide, for the acceptance of scientific work for the periodicals, the observance of those proper standards which have been repeatedly formulated since 1927 but all too frequently not carried out. Especially are verbose articles and reports without positive scientific results to be avoided. Beginners' articles, among which are included numerous medical dissertations, are not to be accepted. No objection shall be raised to the acceptance of especially valuable dissertations which are an actual contribution to science and do not differ in their form from a normal periodical article. The acceptance of monographs, Festschriften, and voluminous Habilitationsschriften for periodical publications is inadvisable. Only indispensable illustrations in a form avoiding every extravagance shall be permitted. So far as an honorarium is still paid for works in scientific periodicals, its maximum amount shall be suitably limited. The delivery to the author of reprints in excessive quantities, which in many cases has led to a decrease in the number of customers, must cease; in other countries reprints are distributed to a much smaller extent, or not at all. . . .

The advance announcement of the prices of periodicals will solve one of the greatest difficulties of American libraries in placing subscriptions to German periodicals, if and when exchange rates become fixed. The reduction in size and price, reversing the policy of the last ten years, was a decided step in the right direction.

During the discussions in Chicago several differences in methods of scientific publishing in Germany and in the United States were noted. In Germany a trade discount of 25 per cent. of the subscription price is given to dealers. No such discount is given by publishers of American, British or French scientific periodicals. Authors of articles in most German periodicals receive liberal honoraria; the cost of photographs and engravings is paid by the publishers. In most other countries contributors to scientific journals not only receive no honoraria, but they may also be required to assume the cost of photographs and plates. American and British scientific periodicals are often subsidized by societies or by foundations. The total production costs of German scientific periodicals as well as some of the expense for the preparation of the manuscripts is ordinarily borne by the publishers. Dr. Springer stated that his firm pays annually to the Deutsche Chemische Gesellschaft for the manuscript of Beilstein's Handbuch, which is prepared by a great staff of chemists, RM 200,000 for each of the two yearly volumes—a cost of $80,000 per volume at the present rates of exchange.

Indexing and abstracting journals were excepted from the agreement. Bibliographical compilations are expensive. It is only through subsidies and support of learned societies that *Chemical Abstracts* and *Biological Abstracts* can be supplied at comparatively low prices. What happens when subsidies are not available is shown by the price of an American publication, the *Agricultural Index,* which has cost some libraries in excess of $200 per year.

Even with subsidies from learned societies the continuation of some American scientific publications seems dubious under present economic conditions. The American Statistical Association is now taking a vote on the continuance of the *Annals of Mathematical Statistics,* stating that its annual subscription rate must be raised to $12.00 on the basis of the present number of subscribers. At the proposed rate the *Annals* will cost next year about 3½ cents a page —not far from the cost per page of many German scientific periodicals.

The librarians present at the A. L. A. conference accepted the concessions made by the German publishers as the inauguration of a new policy which will make possible in the future even further reductions than those now definitely promised. The condensation of important articles and the elimination of less important will be a relief both to scientists and to libraries; on the other hand, it is difficult to see how the basic cost per page can be decreased without subsidies or an increase in number of subscriptions. The depreciation of the American dollar in terms of foreign currency has introduced a new factor which promises difficulties for librarians, for scientists and for German publishers. The income of libraries is decreasing. Even with the reductions made by the German publishers the cost of importations will not be decreased, as the present rates of exchange have practically nullified the reductions, in so far as American libraries are concerned. Under present conditions of exchange the possibility of an increase in the number of American subscriptions to any foreign periodical is doubtful.

There is one point that did not appear in the Chicago discussions but which is worthy of note. For research a knowledge of the literature previously published on the subject under investigation is considered a necessity. The cost of the literature is an insignificant item compared to the total cost of research, but is a desirable and justifiable expenditure, if expensive duplication is to be avoided. A small proportion of funds devoted to research may well be set aside for the purchase of the literature.

The statement of the German representatives, confirmed later by other German publishers, that subscriptions from Japan to German scientific periodicals exceed those from the United States, throws an interesting sidelight on the relation between research and use of the literature. In view of this fact, it is easy to understand why Japanese scientific periodicals are rapidly increasing in reputation and recognition.

Productive research depends upon cumulative knowledge. "Progress in any field of investigation, however, depends upon the extent to which each new investigation builds upon the past and the extent to which it contributes new information and discovers new relationships. Failure so to build upon the past frequently means aimless wandering about in fields previously explored in the same desultory fashion."[3] Under present conditions, with diminishing library budgets and consequently decreasing subscription lists there is a grave danger that the results of research will not become known at all widely and that many valuable and badly needed scientific journals will pass out of existence.[4] German publishers in the curtailment of articles and the omission of the less important material have taken very decided steps in the right direction. They deserve our support and encouragement in their energetic attempts to remedy a most serious situation.

It is to be hoped that with the waning of the world-wide depression increased funds for libraries and increased subsidies to publishers—outlays which represent at the most only a small fraction of the cost of research—will be forthcoming to ensure the availability of the results of scientific investigations to all interested.

CHARLES H. BROWN,
Chairman, A. L. A. Subcommittee on German Periodicals
IOWA STATE COLLEGE

THE UNITED STATES BOTANIC GARDEN

IN SCIENCE of March 2, page 206, Professor Varrelman calls attention to the impending retirement of Director Hess, of the U. S. Botanic Garden. It should be noted that a bill has been introduced into the Senate (Senate Bill 1839) providing for the transfer of the Botanic Garden to the U. S. Department of Agriculture. The main arguments for this transfer may be summarized as follows:

The present government of the Botanic Garden is an

[3] E. W. Allen, Editorial *Experiment Station Record,* 55: 303, September, 1926.

[4] The fear that curtailment of library budgets will indirectly prevent the publication of many valuable scientific articles and books is becoming wide-spread. *Cp.* "Practical Methods for Reducing the Cost of Instruction," by J. D. Russell, in *Journal of Higher Education,* 5: 24–29, January, 1934. "An item of instructional expenditure that has been eagerly pounced upon as offering the opportunity for curtailment in the present emergency is the library budget. It is extremely unfortunate that the necessity of reducing these appropriations has been felt just at the time when instructional methods are being developed which are likely to increase the use of the library. . . . Slashes in library book budgets tend in the long run to be reflected in the incomes of college and university faculty members over the country. A restriction on the purchases of such books not only means a reduction in the royalty income of the ablest and most productive scholars, but greatly increases the difficulty of obtaining publication for scholarly materials of intrinsic worth. Any long-continued policy of restricting the purchases of books for college and university libraries will probably be disastrous for that type of scholarship which depends on publication for its financing."

anachronism, dating from the time in the distant past when there was no organized work in agriculture under the government. To continue it under present circumstances is unnecessary and inexcusable.

Congress is poorly qualified for the management of such an institution, which is an administrative rather than a legislative function. As a consequence, the abuses which Professor Varrelman mentions have grown up.

A Botanic Garden is properly a scientific institution and could function as such under the Department of Agriculture, to the great advantage of the various plant industry activities of the government.

The Botanic Garden should supplement the activities of the National Arboretum, now under development, by performing for herbaceous plants and smaller growths the same service which the Arboretum contemplates for trees.

The transfer is in harmony with the policy of the administration to unite similar activities for economic administration and efficient operation.

The retirement of Director Hess necessitates a certain amount of reorganization, making of the present an auspicious time for the transfer. If the garden is allowed to relapse into the old routine, it will be very difficult to bring about the change in the future.

Horticultural interests are strongly advocating the change and it is to be hoped that workers in other fields of science will do likewise.

W. J. YOUNG

WEST POINT, NEW YORK

DECREASE IN GOVERNMENT APPROPRIATIONS FOR ENTOMOLOGICAL WORK

IN the furtherance of economy, the administrative budget as presented to the Congress of the United States provides for drastic reductions in appropriations for the support of entomological work. During the past thirty years the Bureau of Entomology has grown from a small group of enthusiastic economic entomologists into a great organization of highly trained men who have become recognized authorities in almost every phase of entomology. It is now proposed by the curtailment of support to disorganize and to disrupt this organization, to throw out of employment many entomologists who have dedicated their lives to this branch of scientific work at the invitation of the government.

That insect pests will decrease in importance is unthinkable. Inevitably in the future there will be need for many more specialists in the several fields of entomological work than have so far been employed. Since virtually all these problems cross state lines, they are federal and their solution is a function of the federal government. To disrupt this staff in the face of certainties of future needs, in order for the moment to save a few thousand dollars, is not economy but futile and false show of economy.

We realize that the injustices and unwise proposals here outlined are being equally applied to other lines of scientific endeavor in the government service, but we feel it our duty to point out these facts as they apply to entomology.

We believe that if this false economy is practised this year, the people of the United States will pay for this folly a thousand fold.

C. L. METCALF,
President, Entomological Society of America

E. F. PHILLIPS,
President, American Association of Economic Entomologists

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN EXTRACTOR FOR FLUID SYSTEMS

A SIMPLE apparatus, yet one more efficient than those commonly in use, is suggested for the extraction of various quantities of aqueous fluids by solvents either lighter or heavier than water. It is based upon the principle of a simple but satisfactory and long known gas-washing apparatus, which consists of an inclined tube filled with the wash fluid. A bubble of gas entering the lower end is obliged to roll slowly up through the liquid. Continuous exposure of fresh surface over the rather long path makes the washing very thorough. This idea applied to a globule of solvent traveling through a fluid to be extracted has shown that the effectiveness of the extraction is likewise very satisfactory.

The figure is self-explanatory if the usual types of extractors are compared with it.[1] The ends of the glass tubing in the connections can be fitted together very closely so that no rubber is exposed. No difficulty from the action of solvents on rubber has been encountered. The rubber stopper is at no time in contact with the organic solvent and hence causes no difficulty. Cork stoppers are desirable for the flask and the condenser. Ground glass connections could of course be used.

For solvents heavier than water, the same container or series of containers may be used with a different arrangement of glass bends. In this case the end

[1] Wieland-Gattermann (McCartney), p. 34, 1932; Lassar-Cohn (Osper), p. 207, 1928; Houben, I, p. 572, 1925; Zelmanowitz, *Biochem. Zeitschr.*, 1: 253, 1906; Palkin, Murray and Watkins, *Ind. and Eng. Chem.*, 17: 612, 1925.

with the rubber stopper is somewhat higher than the exit, and an appropriate glass double bend makes connection with the flask. This tube must be large enough (7 mm o.d.) to prevent the formation of a siphon. The solvent must be introduced first to prevent water from entering the return tube. Long extractions with carbon tetrachloride have been carried out in this way without difficulty.

While this type of extractor had no greater efficiency than the type usually used[2] in removing materials easy to extract, such as succinic acid, an appreciable difference was found where the distribution between the solvents was less favorable. Citric acid provided an example of this type.

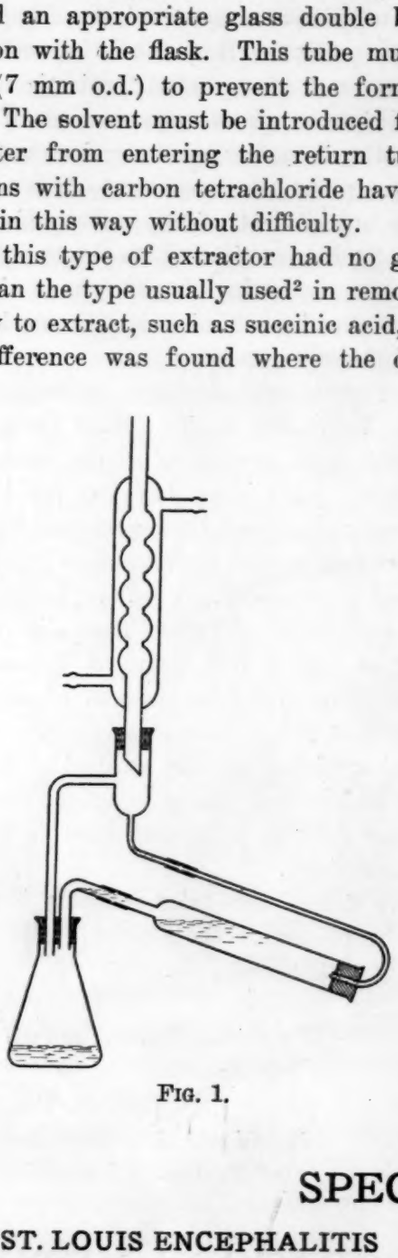

FIG. 1.

Experimental observations are shown in the accompanying tables.

TABLE 1

SUCCINIC ACID

Extraction time (hrs.)	1.5	3.5	6.5
Type A Extractor[2]	0.33g	0.48g	0.50g
Type B Extractor	0.32	0.47	0.50

Table 1 gives the total amount of material extracted in the time given from a solution of 0.50g of succinic acid in 15 ml of water.

TABLE 2

CITRIC ACID

Extraction time (hrs.)	5	10	20	28	35
Type A Extractor ...	0.05g	0.12g	0.30g	0.41g	0.54g
Type B Extractor ...	0.10	0.19	0.38	0.46	0.52

The total amount extracted in the time given from a solution of 0.52g of citric acid in 15 ml of water is shown in Table 2. The rate at which the ether condensed was in all cases about 15 drops in 10 seconds.

WILLIAM F. BRUCE

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SPECIAL ARTICLES

ST. LOUIS ENCEPHALITIS

SEROLOGICAL RELATION TO JAPANESE ENCEPHALITIS AND EXPERIMENTAL STUDIES ON IMMUNITY

THE severe outbreak of encephalitis in St. Louis[1-4] and Kansas City, Mo., during the late summer of 1933, preceded by a similar epidemic in Paris, Ill., in 1932,[5, 6] has been differentiated clinically and epidemiologically from Economo's disease (lethargic or epidemic encephalitis) and likened to the summer epidemic of encephalitis in Japan, designated as Type B.[7] A further comparison of the Japanese and St. Louis disease has now become possible, following the discovery of a virus as the causative agent of the St. Louis encephalitis[8, 9] and a specific immune reaction between this virus and the blood serum of convalescents.[9, 10] The basis for the immunity test rests on the fact that sera from a large majority of tested convalescents of the St. Louis, Kansas City and Paris disease exhibit a specific protective effect when mixed with living virus obtained from the brains of fatal cases and injected intracerebrally into Swiss mice. Animals receiving these mixtures usually remained well, while those given mixtures of virus plus sera from non-contact individuals invariably died.

[2] Quick, *Ind. Eng. Chem. An. Ed.*, 5: 76, 1933; McNair, *Ind. Eng. Chem. An. Ed.*, 5: 76, 1933.

[1] J. P. Leake, *Jour. Am. Medical Assn.*, 101: 928, 1933.

[2] J. F. Bredeck, *Am. Jour. Pub. Health*, 23: 1135, 1933.

[3] J. P. Leake, *Am. Jour. Pub. Health*, 23: 1140, 1933.

[4] T. C. Hempelmann, *Am. Jour. Pub. Health*, 23: 1149, 1933.

[5] W. E. Conklin, personal communication.

[6] H. S. Houston, *Ill. Health Quart.*, 6: 174, 1932 (No. 4).

[7] R. Kaneko and Y. Aoki, *Erg. d. inn. Med. u. Kinderheilk.*, 34: 342, 1928.

[8] R. S. Muckenfuss, C. Armstrong and H. A. McCordock, *Pub. Health Rep.*, 48: 1341, 1933.

[9] L. T. Webster and G. L. Fite, SCIENCE, 78: 463, 1933.

[10] L. T. Webster and G. L. Fite, *Proc. Soc. Exp. Biol. and Med.*, 31: 344, 1933.

Sera from cases of encephalitis in Japan have now been tested for a similar effect. Professor Inada, of Tokyo, kindly sent us sera from 3 persons with a history of encephalitis in August, 1924, aged at that time 60, 50 and 51 years, respectively, and from 9 persons with a similar history in August and September, 1933, aged 17, 17, 20, 26, 33, 46, 53, 62 and 65 years, respectively. In each case fever was noted for 6 to 9 days. The sera were drawn January 10 to 12, 1934. Professor Takaki, of Tokyo, likewise sent us sera from 3 cases from the August, 1933, outbreak. None of these 15 sera showed any protective action against the virus of the St. Louis disease.

Experiments have also been made on the ability of the encephalitis virus to incite a specific immunity in the mouse. Active brain virus given to mice intranasally in doses as small as 10^{-5} gms or intracerebrally in 10^{-8} gms causes death, while the same virus-containing material injected intraperitoneally or subcutaneously in 10^{-2} gm amounts in $\frac{1}{2}$ cc of diluent (which is a million intracerebral and a thousand intranasal lethal doses) rarely proves fatal. Still smaller amounts, 0.001, 0.0001, 0.00001 and 0.000001 gm, when inoculated subcutaneously, induce no symptoms but render them immune to a million intracerebral and a thousand intranasal doses. This induced active immunity has persisted unchanged for 3 weeks and doubtless endures much longer.

This report, therefore, indicates first, that the Japanese B. type and the St. Louis form of epidemic encephalitis are serologically distinguishable; and second, that animals as highly susceptible to infection as are mice, by certain portals of entry of the virus, may be immunized actively by the introduction of minimal amounts of virus—into parts of the body more refractory to its pathogenic action.

LESLIE T. WEBSTER
GEORGE L. FITE

THE LABORATORIES OF THE
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AN ATTEMPT TO ISOLATE VITAMIN A

UP to this time the most powerful concentrate of Vitamin A ever known was a pale yellow oil prepared from a liver oil by P. Karrer and his associates at Zurich. As he measured its potency with the antimony trichloride color reagent it was approximately 10,500 times as rich in Vitamin A as the standard cod-liver oil.

Karrer and Morf,[1] in a recent paper on this subject, refer to a rich concentrate prepared by Carr and Jewell[2] with a very high cod-liver oil value ("C. L. O. value") of 7,800 and to another preparation by Heilbron, Heslop, Morton, Webster, Rea and Drummond[3] with a C. L. O. value of 6,500. These English workers used high-vacuum distillation methods.

In the Severance Laboratory at Oberlin College we have recently obtained a much richer concentrate of Vitamin A than those listed above. Repeated experiments have yielded products with C. L. O. values ranging from 13,000 to approximately 14,000. A convincing number of products ranked above the 10,500 value previously supposed by many to represent pure Vitamin A. Until we can crystallize our richest product, however, we would not be justified in calling it the isolated vitamin, yet it seems probable that it is extremely close to 100 per cent. pure.

The Parke Davis Company and the Abbott Company generously supplied us with the non-saponifiable portion of halibut liver oil as a starting material. This was chilled in methyl alcohol solution, to freeze out cholesterol, etc., filtered cold under nitrogen, transferred to pentane by addition of water, dried over anhydrous sodium sulfate, and then in pentane solution cooled to about $-70°$ C. with the aid of carbon dioxide snow mixed with alcohol and again filtered with careful exclusion of oxygen to remove impurities frozen out. This procedure was, in general, that of Karrer, but from this point on variations were introduced.

The cold pentane solution was next filtered through a Tswett column of very specially prepared carbon (Karrer used alumina and lime), and washed completely through with pure pentane.

The method of Karrer involved washing the strongest color band into the middle section of his column,

TABLE I

VITAMIN A CONCENTRATES RANGING FROM 14,400 TO 10,500 TIMES THE POTENCY OF STANDARD COD LIVER OIL

No.	C.L.O. value	Worker	No.	C.L.O. value	Worker
1.	14,400	Manly	14.	11,400	Hartzler
2.	13,500	"	15.	11,300	"
3.	13,500	Hartzler	16.	11,300	"
4.	12,900	"	17.	11,300	Manly
5.	12,600	"	18.	10,800	Hartzler
6.	12,500	"	19.	10,700	"
7.	12,000	Manly	20.	10,600	"
8.	12,000	"	21.	10,600	"
9.	12,000	"	22.	10,600	Manly
10.	12,000	Hartzler	23.	10,600	"
11.	11,800	"	24.	10,500	Hartzler
12.	11,800	Manly	25.	10,500	"
13.	11,600	"			

NOTE:
Tswett Column I. includes filtrate fractions 1, 2, 7, 13.
" " II. " " " 3, 4, 5, 6, 14, 15, 21, 24, 25.
" " III. " " " 8, 9, 12, 17, 22, 23.
" " IV. " " " 10, 11, 16, 18, 19, 20.

[1] *Helv. Chim. Acta*, 16: 625, 1933.
[2] *Nature*, 131: 92, 1933.
[3] *Biochem. Jour.*, 26: 1178, 1932.

followed by the cutting out of this section and the extraction of the vitamin from this rich portion.

Our pentane fractions were analyzed by the "Official Pharmacopoeia Method" reported by the Cod Liver Oil Color Sub-Committee, using the usual Lovibond tintometer. One worker had used such methods for a year and the other was approved after frequent comparisons.

Needless to state, there are many precautions and many difficulties in working with a substance so extraordinarily sensitive to oxidation (and to light), but these will be discussed in a later paper. It was thought best to make this preliminary announcement before taking time to analyze the concentrate, to determine its molecular weight, its spectral absorption bands, its extinction coefficients and its biological value.

Like the other workers mentioned, we secured a pale yellow, viscous oil. We shall continue our attempts to crystallize it.

HARRY N. HOLMES
HAROLD CASSIDY
EVA HARTZLER
RICHARD MANLY

OBERLIN COLLEGE

THE EFFECT OF X-RAYS ON GROWTH SUBSTANCE AND PLANT GROWTH

IT has long been known that the growth of plant and animal tissues is inhibited by x-radiation. The amount of inhibition has generally been found to be a function of the amount of irradiation up to a certain lethal dosage which varies greatly with different types of cells and under different experimental conditions.

In this preliminary report of work done during the last year on the effect of x-rays on growth substance, the "growth hormone" of plants, it is possible to explain the immediate effects of irradiation in terms of its action on a specific chemical substance. The high voltage x-ray tube of the W. K. Kellogg Radiation Laboratories of the California Institute of Technology, which produces a well-defined beam of hard γ-rays of uniform intensity (soft rays being eliminated by successive steel, lead and aluminum filters) was used. The dosages given varied from 20 to 5,000 Röntgen units applied at different rates between 15 and 50 Röntgen units per minute at 750,000 to 925,000 volts and 3 to 4 milliamperes. The growth substance was irradiated in different media and solvents, such as agar blocks of standard size and concentration, water and other solutions of known activity. A few species of plants were directly irradiated. The amount of growth substance remaining after irradiation was determined by the usual *Avena* technique.

Growth substance was inactivated by irradiation both in solution and in the intact plant and by comparable dosages. Under certain conditions the inactivation was complete. When a water solution of growth substance was irradiated in an atmosphere of nitrogen there was no immediate inactivation, indicating that the reaction is an oxidation.

Tips from irradiated plants, placed on agar blocks, showed a large decrease in growth substance diffusing out from them as compared with tips from control plants. This was true even when relatively small dosages were administered, so that the growth rate of the intact plant would be only temporarily decreased. This difference in amount of growth substance diffusing out from the tip is not due to an effect produced by irradiation on the rate of growth substance transport through the plant, because the transport is not decreased by previous irradiation of the plant.

Irradiated seedlings showed a decrease in growth rate. But similar seedlings, given a continuous supply of growth substance immediately after irradiation, were able to maintain their normal growth rate compared with similarly treated nonirradiated controls. No stimulation of growth by irradiation was observed for the intensities used in these experiments.

Many workers have found that regeneration in plants through the development of buds and shoots is greatly increased by moderate dosages of x-rays. Since it is known that growth substance inhibits the outgrowth of buds, this regeneration may now be explained by the inactivation of growth substance by x-rays, rather than interpreted as a stimulative effect on the cells irradiated.

These experiments show that the primary action of x-rays on the growth of plants is through the inactivation of growth substance. They offer a simple technique whereby the immediate effects of irradiation on the living cell may be quantitatively studied.

FOLKE SKOOG

CALIFORNIA INSTITUTE OF TECHNOLOGY

BOOKS RECEIVED

DOWNING, ELLIOT R. *An Introduction to the Teaching of Science.* Pp. vii + 258. University of Chicago Press. $2.00.

MEYERHOFF, HOWARD A. *Geology of Puerto Rico.* Pp. 306. 45 figures. The University of Puerto Rico.

PACKARD, EARL L., REMINGTON KELLOGG and ERNST HUBER. *Contributions to Palaeontology: Marine Mammals.* Pp. 136. Illustrated. Carnegie Institution of Washington.

Report of the Secretary of the State Board of Agriculture and of the Experiment Station of the State of Michigan, 1931–1932. Pp. 288. 29 figures. Board of Agriculture of the State of Michigan.

SIERPINSKI, WACLAW. *Introduction to General Topology.* Translated by C. Cecilia Krieger. Pp. x + 235. University of Chicago Press. $4.00.

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